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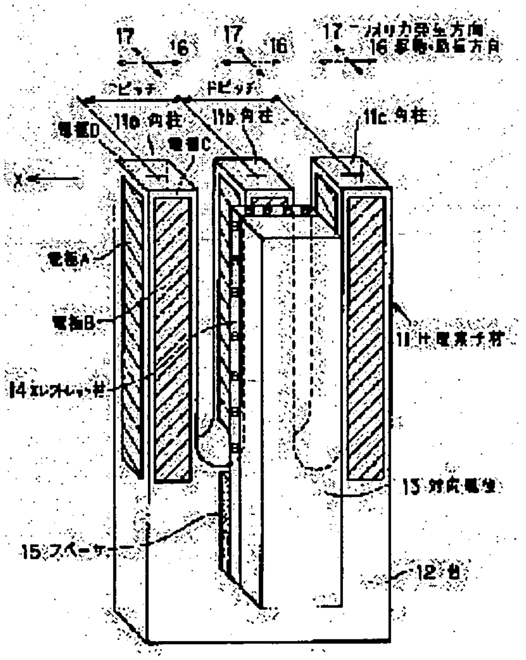
(54) ANGULAR VELOCITY SENSOR

(57)Abstract:
PROBLEM TO BE SOLVED: To provide an angular velocity sensor which is comparatively low in cost and which can obtain a high sensitivity and a high detecting accuracy in the angular velocity sensor which is effective in a car-body control system, a navigation system or the like in a vehicle or the like.

SOLUTION: From a piezoelectric element material 11 such as a crystal, a ceramic or the like, a square pillar 11a, a square pillar 11b and a square pillar 11c are cut off integrally with a base 12. An electrode A, an electrode B, an electrode C and an electrode D are installed on the side face of every angular pillar. An AC voltage is applied. The electrodes are driven to their arrangement direction so as to be set to an excitation state. A slight gap is constituted of a spacer 15 between the angular pillar 11b in the center and the side-face electrode B which is parallel to its excitation direction. A counter electrode 13 on which an electroret material 14 composed of a polymer material or the like such as Teflon or the like is installed is arranged on the surface. Thereby, a change in the capacitance of the gap is treated as a change in a voltage, and the Coriolis force is detected by an electric impedance converter (an FET).



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CLAIMS

[Claim(s)]
[Claim 1] The piezoelectric-device material which has arranged the prism on a base and has arranged one piece or plurality on a straight line, The electrode which is prepared in each side face of said prism, drives in the array direction of said prism by alternating-voltage impression, and is excited, The counterelectrode prepared so that few openings might be constituted between one piece prepared in the side face parallel to the excitation direction of said prism, or said two or more electrode surfaces, The angular-velocity sensor equipped with the electric IMBI dance converter which is connected to said counterelectrode, takes out the capacity change between said openings as electrical-potential-difference change, and detects Coriolis force.
[Claim 2] The angular-velocity sensor according to claim 1 characterized by said counterelectrode taking out the output of the capacity change between said openings by the electric impedance converter which was prepared so that few openings might be constituted among said two or more electrode surfaces prepared in the side face of both parallel to the excitation direction of said prism, respectively, and was connected to said each counterelectrode through a differential circuit.
[Claim 3] The angular-velocity sensor according to claim 1 or 2 characterized by forming said prism by logging from piezoelectric-device material.
[Claim 4] Claims 1 or 2 characterized by making ejection of an output possible by the output terminal prepared in said case while holding in metal casing and being mostly maintained at the sealing condition, or an angular-velocity sensor given in three.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the angular-velocity sensor which detects an angular velocity effective in the car-body control system in a car etc., a navigation system, etc., especially the angular-velocity sensor of an electret condenser type.
[0002]
[Description of the Prior Art] Drawing 7 shows the example of a configuration of the conventional angular-velocity sensor. In drawing 7 (a), 1 is the metal diaphragm of a U character mold, it has the metal diaphragms 2 and 3 of two sheets arranged in the upper part at this and a right angle, and piezoelectric devices 1a, 1b, 2a, and 3a are being fixed to each metal diaphragms 2 and 3 by adhesives etc. 4 is a fixed shaft which carries out fixed support of these diaphragms, that is, the metal diaphragm will constitute the tuning fork condition.
[0003] Piezoelectric-device 1a is a component for actuation for driving this tuning fork (excitation), and is driven by impression of alternating voltage. Although 1b may also be used for actuation, generally this output is used and it is used for the monitors for stabilizing an oscillation. In order that drive frequency may enlarge the amplitude, it is common to drive according to the resonance frequency of a metal diaphragm, and an oscillation is obtained in the direction like 5. Supposing it gives a revolution in the direction of a clockwise rotation as 6 been a revolution detection shaft and shown in drawing, in order for Coriolis force Fc as shown in drawing 7 (b) to occur and to vibrate the metal diaphragms 2 and 3, the electromotive force of an opposite phase will be respectively acquired by piezoelectric devices 2a and 3a. Therefore, the output proportional to angular velocity can be obtained by taking the differential of this each output of detection. Generally, since it is very small, in order to obtain a big output as much as possible, the output by Coriolis force is constituted so that the resonance frequency of the metal diaphragm section which Coriolis force generates may be doubled with the tuning fork frequency of an actuator metal diaphragm. In addition, in drawing 7 , in omega, angular velocity and v show the velocity of vibration, and m shows the mass of a diaphragm.
[0004]
[Problem(s) to be Solved by the Invention] However, the following technical problems occur in the above-mentioned conventional angular-velocity sensor.
1. Although the metal diaphragm for tuning fork actuation and the metal diaphragm for Coriolis force detection are made from the same structure, since an actuator and a detecting element are not the same metal diaphragms, it is dramatically difficult to make each resonance frequency in agreement, and it becomes difficult to raise detection sensitivity.
2. Since the configuration of a metal diaphragm is complicated, high process tolerance is required and the variation in a cost rise and detection precision is unavoidable.
3. Since the piezoelectric device is fixed to a metal diaphragm with adhesives etc., the fixed variation is large and tends to affect detection precision, the temperature characteristic, etc.
4. Although it negates each other by differential about the deformation to this direction by oscillation

since there are two metal diaphragms of a detecting element, about the deformation to hard flow equivalent to Coriolis force, it will detect as an output. Therefore, there is a weak fault to the oscillating noise accompanied by the angular moment.

[0005] This invention and the above-mentioned conventional problem are solved, and it is comparatively cheap and aims at offering the angular-velocity sensor which was excellent in high sensitivity and high degree of accuracy.

[0006]

[Means for Solving the Problem] In order to solve the above-mentioned problem, this invention starts and forms piezoelectric-device material, such as Xtal and a ceramic, in a prism. Said prism is fixed on the base of piezoelectric-device, one, or exception material on one piece or a plurality (tuning fork condition) straight line, and an electrode is formed in each side face of a prism. To each part electrode by alternating-voltage impression So that it may drive in the array direction of a prism, it may consider as an excitation condition and the insulating configuration of 1 of the side-face electrodes of the prism located in these excitation direction and parallel or few openings among two or more electrode surfaces of each may be carried out Prepare the counterelectrode which fixed the electret material which consists of macromolecule material, such as Teflon, etc. by welding etc. in a front face, and the electric IMBI dance converter (FET) which takes out the capacity change between said openings as electrical-potential-difference change is minded. It constitutes so that the output by Coriolis force may be taken out, and an oscillating object is the piezoelectric device itself, such as Xtal and a ceramic, and constitutes actuation and detection from same oscillating object.

[0007] By the above configuration, it is comparatively easy to make the resonance frequency of actuation and detection in agreement, there is no immobilization by adhesives etc., process tolerance is also started, it is only processing, and it is possible to stop HARATSUKI. Moreover, since it has high Q in actuation and the electret capacitor method with an easy configuration with high conversion efficiency is used for Coriolis force detection for the amplitude of Q with a high piezoelectric device using the piezoelectric device with sufficient excitation effectiveness, it is comparatively cheap and high sensitivity and high detection precision are acquired. Although it is easy to generate the effect of an oscillating noise somewhat about the oscillation of the direction of coriolis about the effect of an oscillation, the effect of the excitation direction is also small. Moreover, constitutionally, since resonance frequency can be conventionally set up highly as compared with elegance, it has the advantage which cannot be easily influenced of an oscillation.

[0008]

[Embodiment of the Invention] The piezoelectric-device material to which invention of this invention according to claim 1 has arranged the prism on a base, and has arranged one piece or plurality on a straight line, The electrode which is prepared in each side face of said prism, drives in the array direction of said prism by alternating-voltage impression, and is excited, The counterelectrode prepared so that few openings might be constituted between one piece prepared in the side face parallel to the excitation direction of said prism, or said two or more electrode surfaces, It is the angular-velocity sensor equipped with the electric IMBI dance converter which is connected to said counterelectrode, takes out the capacity change between said openings as electrical-potential-difference change, and detects Coriolis force. Since actuation and detection are constituted from same oscillating object, it is easy to double each resonance frequency, and the amplitude of Q with a high piezoelectric device is efficiently changed into Coriolis force detection and the configuration uses the easy electret capacitor method, It has an operation that it is comparatively cheap and high sensitivity and high detection precision are acquired.

[0009] Invention of this invention according to claim 2 is prepared so that said counterelectrode may constitute few openings among said two or more electrode surfaces prepared in the side face of both parallel to the excitation direction of said prism, respectively. It is the angular-velocity sensor according to claim 1 characterized by taking out the output of the capacity change between said openings by the electric impedance converter connected to said each counterelectrode through a differential circuit, and has an operation that the output level of Coriolis force can be enlarged further..

[0010] Invention of this invention according to claim 3 is an angular-velocity sensor according to claim

1 or 2 characterized by forming said prism by logging from piezoelectric-device material, and has an operation that process tolerance is also good and variation is small, for logging processing.
[0011] Invention of this invention according to claim 4 is claims 1 or 2 characterized by making ejection of an output possible by the output terminal prepared in said case, or an angular-velocity sensor given in three, and has an operation that high dependability can be acquired while it is held in metal casing and is mostly maintained at a sealing condition.
[0012] Hereafter, the gestalt of operation of this invention is explained using drawing 6 from drawing 1 .

(Gestalt 1 of operation) Drawing 1 shows the perspective view of the angular-velocity sensor of the electret condenser type in the gestalt of operation of the 1st of this invention, and drawing 2 shows the side elevation in drawing 1 . Although the gestalt of this operation describes taking the case of the case where single crystal piezoelectric-device material, such as Xtal, is used as piezoelectric-device material, the same operation effectiveness can be acquired by changing the configuration, circuitry, etc. of an electrode also about the case where a ceramic piezoelectric device etc. is used.
[0013] In drawing 1 and drawing 2 , X is an electrical axis in the case of Xtal etc. generally said, and it is desirable to start and process it in consideration of these shaft orientations. it is also possible for 11 to start, and to be the piezoelectric-device material which constituted three prisms 11a, 11b, and 11c in a base 12 and one, not to prism 11a, 11b and 11c, and really come out of a base 12, to create in exception material by processing, and to carry out a fixed configuration. The reason for forming two or more prisms makes a tuning fork condition, it is for demonstrating the effectiveness of actuation and excitation to the maximum extent, and obtaining the big amplitude, for example, at least one prism is contained in this invention, and although there is size of effectiveness, it is also utilizable.
[0014] Electrodes (slash section) A, B, C, and D are formed in each field of each prism 11a, and 11b and 11c of printing, vacuum evaporationo, plating, etc., and like the connection of drawing 3 mentioned later, the circuit connection of each part electrode is taken out using wire bonding etc., and they perform it. 13 is a counterelectrode, is fixing the electret material 14 which becomes a front face from high polymer films, such as Teflon, by welding etc., and is carrying out the insulating configuration of few openings between the side-face electrodes B located in the actuation / excitation direction 16 of each prism, and parallel by SU **-SA 15 grade. A base 12 and a counterelectrode 13 are fixed by a certain approach. Since the center-of-gravity pitch of a prism is shown and change / excitation effectiveness of resonance frequency etc. produces change also by this pitch configuration, P is set as the optimal dimension.
[0015] Drawing 3 is the circuit diagram showing the connection in the angular-velocity sensor shown in drawing 1 , R shows resistance and OSC shows an oscillator. 21 is the example of the direction of electric field, and it is an electric impedance converter for changing the electric IMBI dance and taking out a voltage output, since the space capacity Co of 22 of an electret capacitor is very small and the impedance is dramatically high, for example, FET etc. is used. The electrodes A and C of prism 11a and 11c and the electrodes B and D of prism 11b are connected to the end of Oscillator OSC, respectively, and the electrodes B and D of prism 11a and 11c and the electrodes A and C of prism 11b are connected to the other end of Oscillator OSC through Resistance R, respectively. A counterelectrode 13 is connected to the electric impedance converter 22, and a detection output is taken out between the output of the electric impedance converter 22, and a ground.
[0016] Next, the actuation in the gestalt of this operation is explained. If it drives with Oscillator OSC to each electrodes A, B, C, and D of each prism 11a, and 11b and 11c, each prism 11a, and 11b and 11c will vibrate in the direction shown by the arrow head 16. On the other hand, to the electret material 14, Charge Q (it subtracts in this example) is coming by telegraph. That is, when the capacity Co of space is formed between the electrode surfaces B of a counterelectrode 13 and Prisms 11a, 11b, and 11c, for example, Prisms 11a, 11b, and 11c vibrate in the excitation direction 16 and the right-angled direction (the Coriolis force generating direction 17), change of **C arises in this capacity and electrical-potential-difference change **V occurs as following with the charge of an electret.
V=Q/C, i.e., the detection method of an electret condenser type, is realized, and it is known that this

method has high conversion efficiency.

[0017] Drawing 4 is a perspective view at the time of holding the angular-velocity sensor 30 constituted as mentioned above in metal casing 31. It is a vertical mold and drawing 4 (b) is the example of a horizontal type, output terminal 32 grade is prepared in metal casing 31, and drawing 4 (a) is constituted so that a sealing condition may be maintained mostly. In order to adsorb small dust etc. weakly by water and moisture, the point which gets worse dependability has the fault of an electret mold. However, it becomes possible like the above to make it operate satisfactory at all by holding in a case.

[0018] As mentioned above, according to the gestalt 1 of this operation, three prisms 11a, 11b, and 11c cut down with the base 12 from the piezoelectric-device material 11 are arranged on a straight line. While making the electrodes A, B, C, and D prepared in each side face of these prisms connect and excite Oscillator OSC Between the electrodes B prepared in one side face of prism 11b of middle, a spacer 15 constitutes few openings, arrange a counterelectrode 13 through the electret material 14 to it, and the electric impedance converter 22 is connected to this counterelectrode 13 between. Since Coriolis force was detected by taking out the capacity change between said openings as electrical-potential-difference change It is comparatively easy to make the resonance frequency of actuation and detection in agreement, and there is no immobilization by adhesives etc. Also start process tolerance, are only processing and it is possible to stop HARATSUKI. And since it has high Q in actuation and the electret capacitor method with an easy configuration with high conversion efficiency is used for Coriolis force detection for the amplitude of Q with a high piezoelectric device using the piezoelectric device with sufficient excitation effectiveness, it is comparatively cheap and high sensitivity and high detection precision are acquired.

[0019] (Gestalt 2 of operation) Drawing 5 is the perspective view showing the gestalt of operation of the 2nd of this invention, and the same part as drawing 1 and drawing 2 is attached with the same sign. That the gestalt 2 of this operation differs from the gestalt 1 of operation As it is having countered the electrode surfaces B and D of both parallel to the excitation direction of prism 11b of middle, and having arranged the counterelectrode 13 through the electret material 14 and is shown in drawing 6 The electric impedance converter 22 is connected to counterelectrode 13a arranged at Electrode B side. The same electric impedance converter 23 as counterelectrode 13b arranged at Electrode D side is connected. It has the advantage that the output difference of the opposite phase of both electric impedance converters 22 and 23 is taken out from a differential circuit 24, and the output of Coriolis force can be taken out still more greatly.

[0020] With the gestalt of each above operation, although they are three cases, 11a, 11b, and 11c, in two or more configurations, a prism can consider various configurations with a number, the sense, etc., and the ejection of the output of Coriolis force can also be taken out from plurality, and it can also compound it from a piece. However, considering efficient things including cost etc., it is thought appropriate Prisms 11a, 11b, and 11c constitute a three-piece tuning fork, and detect from prism 11b of the middle. In addition, if the number of detection electrodes increases, it will also become difficult to find the optimum point. It is ** which it divides that the pitch P of resonance frequency of the excitation direction and the direction of Coriolis force of Prisms 11a, 11b, and 11c (center-of-gravity pitch) tends to correspond as for the smaller one, and effectiveness becomes [the direction of this pitch] good according to the experiment.

[0021]

[Effect of the Invention] This invention starts and forms piezoelectric-device material, such as Xtal and a ceramic, in a prism as mentioned above. Said prism is fixed on the base of piezoelectric-device, one, or exception material on one piece or a plurality (tuning fork condition) straight line, and an electrode is formed in each side face of a prism. To each part electrode by alternating-voltage impression So that it may drive in the array direction of a prism, it may consider as an excitation condition and the insulating configuration of 1 of the side-face electrodes of the prism located in these excitation direction and parallel or few openings among two or more electrode surfaces of each may be carried out Prepare the counterelectrode which fixed the electret material which consists of macromolecule material, such as Teflon, etc. by welding etc. in a front face, and the electric IMBI dance converter (FET) which takes out the capacity change between said openings as electrical-potential-difference change is minded. Since it constituted so that the output by Coriolis force might be taken out, and an oscillating object is the piezoelectric device itself, such as Xtal and a ceramic, and constituted actuation and detection from same oscillating object It is comparatively easy to make the resonance frequency of actuation and detection in agreement, there is no immobilization by adhesives etc., process tolerance is also started, it is only processing, and it is possible to stop HARATSUKI. Moreover, since it has high Q in actuation and the electret capacitor method with an easy configuration with high conversion efficiency is used for Coriolis force detection for the amplitude of Q with a high piezoelectric device using the piezoelectric device with sufficient excitation effectiveness, it is comparatively cheap and high sensitivity and high detection precision are acquired.

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] The perspective view of the angular-velocity sensor in the gestalt 1 of operation of this invention
[Drawing 2] The side elevation of the angular-velocity sensor in the gestalt 1 of operation of this invention
[Drawing 3] The circuit diagram of the angular-velocity sensor in the gestalt 1 of operation of this invention
[Drawing 4] The perspective view showing the case of the (a) vertical mold which held the angular-velocity sensor by this invention in the case, and the case of the (b) horizontal type
[Drawing 5] The perspective view of the angular-velocity sensor in the gestalt 2 of operation of this invention
[Drawing 6] The circuit diagram of the angular-velocity sensor in the gestalt 2 of operation of this invention
[Drawing 7] The perspective view (a) and the explanatory view of operation (b) of an angular-velocity sensor in the conventional example
[Description of Notations]
11 Piezoelectric-Device Material
11a, 11b, 11c Prism
12 Base
13 Counterelectrode
14 Electret Material
15 Spacer
16 The Actuation / Excitation Direction
17 The Coriolis Force Generating Direction
21 The Direction of Electric Field
22 23 Electric impedance converter
24 Differential Circuit
30 Angular-Velocity Sensor
31 Case
32 Output Terminal
A, B, C, D Electrode
P Pitch

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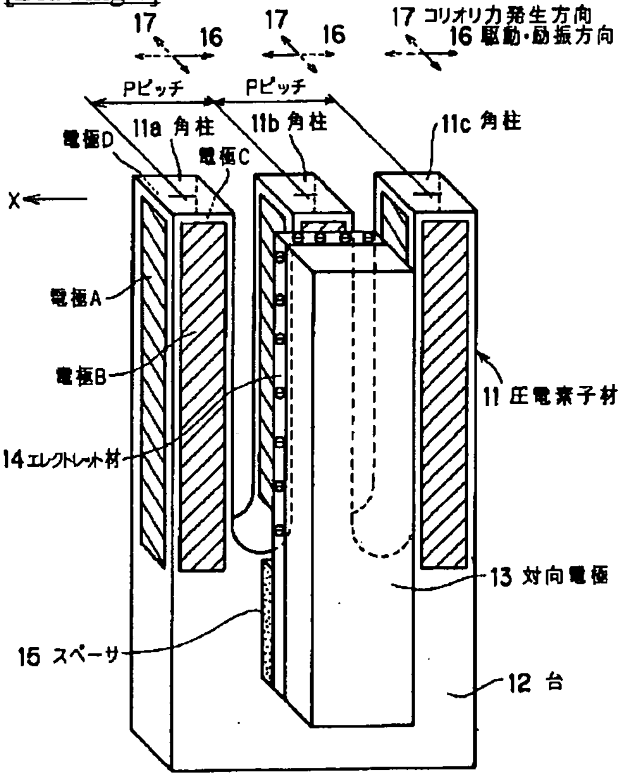
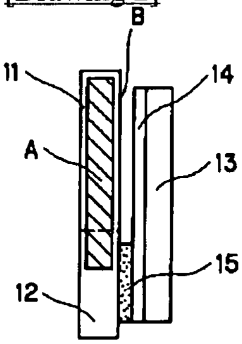
DRAWINGS

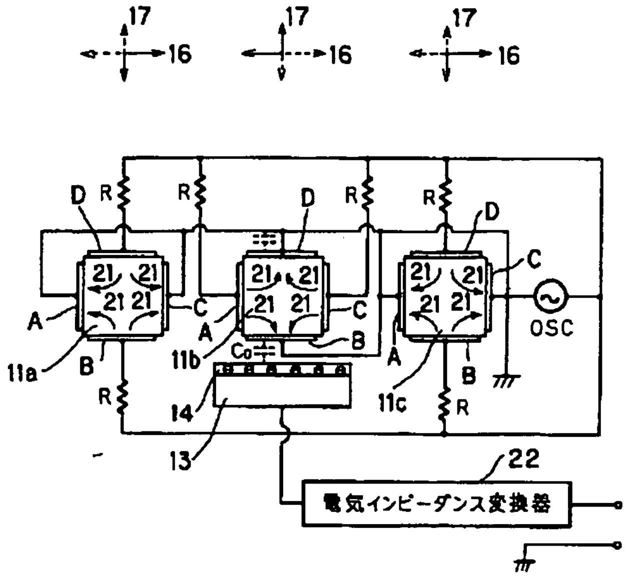
[Drawing 1]



[Drawing 2]



[Drawing 3]



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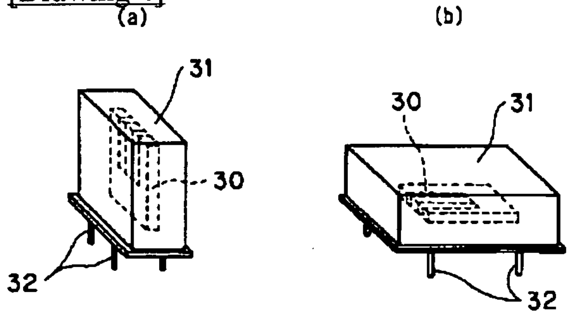
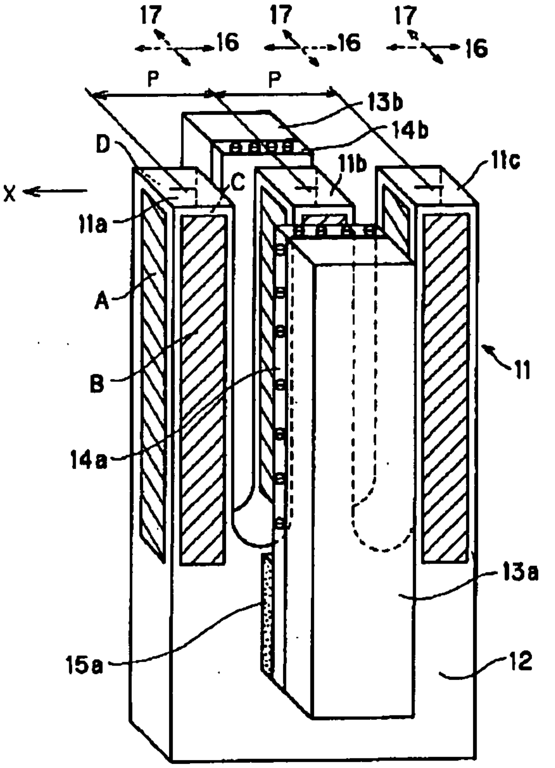
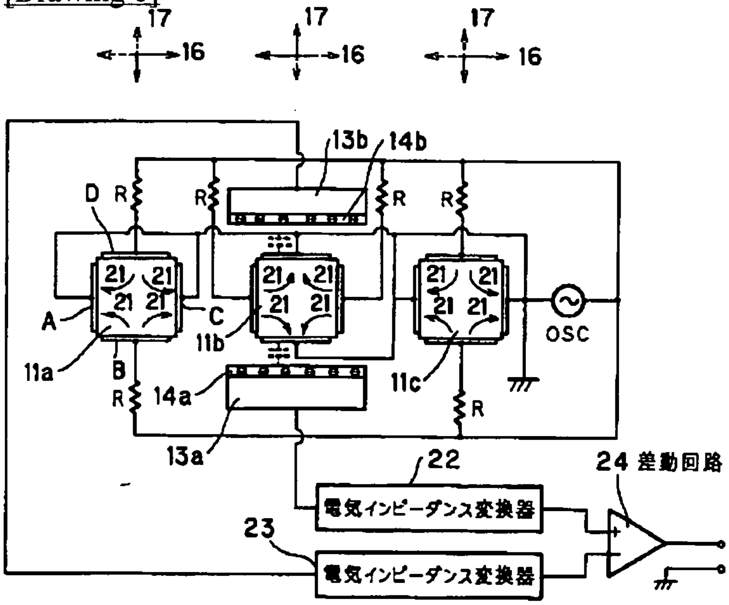


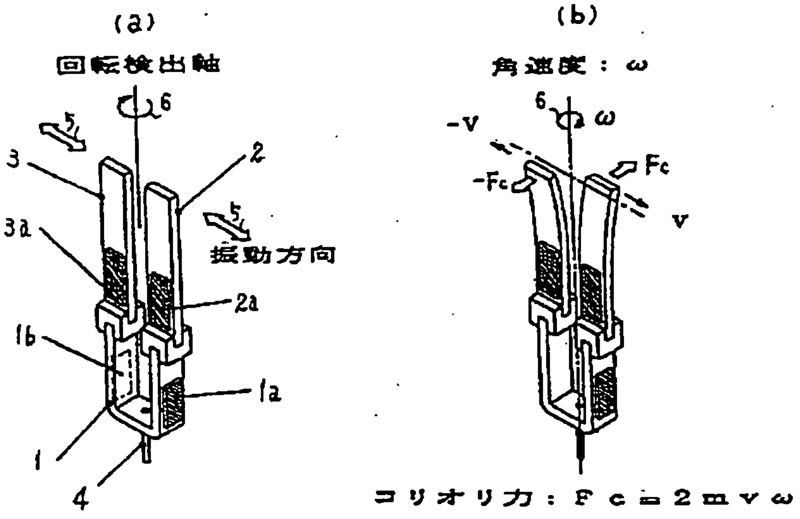
[Drawing 5]



[Drawing 6]



[Drawing 7]



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